A Synopsis
on

SYNTHESIS, CHARACTERIZATION AND APPLICATIONS OF SOME UNDOPED AND DOPED TERNARY OXIDE NANOPARTICLES

For

Partial fulfillment of Ph. D. Degree in Chemistry

SUBMITTED BY
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OUTLINE OF PROPOSED RESEARCH WORK

1.	**Name of Scholar:**	**Mrs. JYOTI SHARMA**
2.	**Title of the Research:**	**SYNTHESIS, CHARACTERIZATION AND APPLICATIONS OF SOME UNDOPED AND DOPED TERNARY OXIDE NANOPARTICLES**
3.	**Location:**	
(a)	**Organization/Department where the work is to be done:**	**Department of Science, Faculty of Arts,Science&Commerce Mody University of Science and Technology, Lakshmangarh (Raj.)**
(b)	**Geographical Area of Investigation If any:**	**Not-Applicable**

4. Importance of proposed investigation:

Water is finite on the planet earth. Requirement of water in various industries is quite large. One of them is textile industry, which uses vast amount of water in all their processing operations. Almost all steps including scouring, bleaching and mercerizing use water and each one of these steps must be followed by thorough washing of fabric to remove all chemicals used before moving on to the next step. Indian textile industry uses 425,000,000 gallons of water every day[1] or it takes about 20 gallons of water to produce one yard of upholstery weight fabric.[2]To minimize the environmental impact of textile effluents, mainly related to their high coloration and the presence of toxic or carcinogenic dyes, a number of technologies such as electrochemical, precipitation, bio-absorption, bio-oxidation, ozonation, membrane separation processes, physico-chemical treatment and chemical oxidation are available. Semiconductors have been extensively used for their potential of decolorizing textile effluent, in the form of isolated and combined procedures.

Thus, in the proposed investigation, efforts will be made to investigate a new improved method for the degradation of some dyes using different undoped/doped ternary oxide nanoparticles.

5. Objective of the proposed study:

- To synthesize ternary oxide nanoparticles using cerium (from lanthanum series) and 3d transition metal ions and its doped form.
- Synthesized photocatalysts will be characterized and explored for its photocatalytic activity in the degradation of some dyes.
- To carry out optimization of the degradation process according to the mass of the semiconductor, treatment time, dye concentration, light intensity etc.

6. Review of work already done on the subject:

The removal of organic pollutants from water has drawn the attention of scientists and a lot of work has been carried out in this field[1-3]. In recent years, heterogeneous photocatalysis has received much attention for environmental applications such as air purification, water disinfection, hazardous remediation and water purification. Many photocatalysts like TiO_2, ZnO, Bi_2S_3, Sb_2S_3, and vanadate, are useful in degradation of many organic contaminants[3]. Sugar assisted stable monometallic nanoparticles were synthesized by wet chemical method by Panigrahi et al[4].

The development of nanomaterial processing technique is essential to make better use of nanoparticles and solve application problem related to it. New chemical synthesis methods for producing nano sized oxides particles in gas phase and producing biocompatible polymeric nano composite particle in the solution phase were elucidated by Jana et al.[5] Degradation of organic G, amonoazo dye, was investigated in aqueous solutions using Fe-Ni bimetallic nanoparticles by Bokare et al.[6] Another interesting study was carried out on photocatalytic degradation of various dyes using P25 Degussa as catalyst and it was compared with adsorption properties by Hachem et al.[7] Chakrabarti and Dutta[8] explored the application of ZnO as an effective catalyst for photodegradation of Methylene blue and EosinY using 16 W lamp as source of UV radiation. TiO_2 assisted photocatalytic degradation of azo dyes in aqueous solution under solar and UV radiation by following either the

decolourization rate or formation of end product was studied by Konstantinon and Albanis[9].

Photocatalytic degradation of indigo and indigo caramine has been investigated both; in aqueous heterogeneous suspension and in solid waste by Manonet al[10]. Nanocrystalline $TiO_2$was synthesized by Tayade et al.[11] via controlled hydrolysis of titanium tetra isopropoxide.The anatase phase was converted to rutile phase by thermal treatment at 1023 K for 11 Hours. They compared both the phases for the degradation of acetophenone, nitrobenzene, methylene blue and malachite green present in aqueous solution. Ameta et al.[12] studied photocatalytic bleaching of cationic dyes in the presence of Fe (III) oxide and it was observed spectrophotometrically. Direct photocatalytic degradation of rhodamine B with thiocyanate complex of iron and hydrogen peroxide has been reported by Lodha et al.[13] The degradation of the dyes was monitored spectrophotometrically and it followed pseudo first order kinetics.

Recent development in use of some metal oxide semiconductors as photocatalyst in advanced oxidation process for treatment of dyes in waste water was reported by Shen Chan et al.[14] Titanium oxide assisted photocatalytic degradation of methylene blue containing different concentration of ^{-}OH was carried out by Madhu et al.[15] Photocatalytic degradation of phenol red using complexes of some transition metals and hydrogen peroxide was explored by Lodha et al.[16] Pawar et al.[17] studied photocatalytic bleaching of tolonium chloride on zirconium phosphate in presence of light. The effect of different parameters was studied on the rate of degradation. A similar study of synthesis and characterization and use of novel bimetal oxide catalyst for photoassisted degradation of malachite green dye was also conducted by Ameta et al.[18] Cerium-Iron Oxide catalyzed photodegradation of brilliant blue was also conducted by Ameta et al.[19]

Highly crystalline metal oxide nanoparticle such as CoO, ZnO, Fe_3O_4, $BaTiO_3$ were synthesized in just a few minutes by reacting metal alkoxides, acetates with benzyl alcohol under microwave heating by Bilecka et al.[20] Content nanoparticles of some functionally advanced binary/ternary metal oxides (MnO_2, $ZnMn_2O_4$) have been synthesized using metal acetyl acetonates as the starting

precussor material and microwave as the source of energy, in a process developed in detail by Brahma et al.[21]

7. Research gaps identified in the proposed field of investigation:

Photocatalysis has been used as an eco-friendly method to treat the organic as well as inorganic pollutants. Various semiconductors used as photocatalysts have their own limitations. In the proposed research various ternary oxides nanoparticles will be synthesize and explore them as photocatalysts for the photodegradation of different dyes followed by doped/undoped approach. In present work, efforts will be made to enhance the photocatalytic activity of nanoparticles on various dyes by red shift and increased absorption of the intensity of light in visible region due to doping.

8. Research Methodology:

- **Hypotheses to be tested:** Not applicable.
- **Sources of Information:** Chemical Abstracts, Current Contents, CAPS, Journals, Internet, etc.
- **Tools and Techniques of Research:** Spectrophotometry will be used to observe the effect of different parameter on the rate of reaction.

9. Tentative Chapterization:

The present thesis will be divided into three chapters-

Chapter I - It will include an extensive literature survey, in particular, photocatalytic degradation of various organic pollutants by different photocatalysts.

Chapter II - It will be divided into two parts-

Chapter IIA - It will describe the background and plan of present work.

Chapter IIB - It will contain the experimental details.

Chapter III - It will present the observed experimental data for different dye systems. This chapter will be divided into parts. Each sub-chapter will give the details of observations related to an individual organic pollutant (dye). It will also give results and their explanation for rate affecting

parameters like, pH, concentration of pollutant, light intensity etc. A tentative mechanism for each system will also be proposed.

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Signature of the Candidate

OUTLINE APPROVED

Dr. K. L. Ameta 3/5/2014

Supervisor

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Email attached as approval

Submission of synopsis of Mrs. Jyoti Sharma%E2%80%8F

Rakshit Ameta 02-05-2014
To: klameta77@hotmail.com

Dear Dr. Ameta,

I have checked and made necessary corrections in the synopsis of Mrs. Jyoti Sharma, who will be jointly supervised by us. You may submit the synopsis for further necessary action.

With regards.

Yours sincerely,
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